Economic Impacts, Value Added, and Benefits in Regional Project Analysis

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This paper addresses five issues encountered when estimating secondary benefits in regional project analysis: (*a*) the correction for opportunity cost of factors used, (*b*) the treatment of mobile factors, (*c*) the effect of economies of size, (*d*) the role of forward linkages, and (*e*) the role of spatial structure of economic regions. The first four are reasons that only a small part, if any, of regional impacts can be treated as regional net benefits. The fifth is a reason that, when secondary benefits or damages do exist, their correct estimation can depend on the spatial structure of the affected areas.

Key words: economic impacts, net benefits, regional project analysis.

Economists are often asked to assess the benefits or damages from a past or future event on the economy of some region. Examples include assessment of regional economic consequences of alternative timber harvest levels, entry or exit of a manufacturing plant, or the construction or demise of an irrigation project. Analysts have increasingly turned to the tools of regional analysis, especially regional input-output (I-O) models, to estimate these benefits or damages. Regional I-O models are constructed to estimate linkages among sectors of the economy of a target region. In this way, an event affecting one sector can be traced through the regional economy, and the change in value added, income earned by primary factors of production, can be estimated. This approach allows estimation of both direct impacts caused by the initial change in the affected sector and secondary impacts which result as the direct spending works its way through the economy.

Direct income impacts of a project are the factor payments: the wages, rents, and profits earned by input factors used directly by the project. Secondary impacts result when the directly affected sector buys inputs from other sectors (backward linkages) or produces outputs that become inputs for expansion of other regional industries (forward linkages). A new irrigation project will cause agriculture to buy more from backward linked fertilizer, machinery, and insurance sectors, and may allow expansion of forward-linked livestock and food-processing sectors. The directly affected sector, along with backward and forward linked sectors generate value added consisting of income earned by the input factors. Thus, the available tools, including I-O models, allow us to estimate the impacts of the project or event on regional economic activity. The impact analysis is the easy part; the step that causes problems is translating these impacts into estimates of benefits or costs.

This paper addresses several methodological issues which arise and errors that are committed when estimates of regional economic impact are used to derive estimates of regional primary and secondary project benefits. Most of the issues noted in this paper apply whether the impact estimates are based on I-O models, economic base analyses, econometric models, or the cost ac-

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counting commonly used in benefit-cost analysis. Some of these issues are noted in the regional analysis literature (Stabler, Van Kooten, and Meyer; Hamilton and Gardner), but we have found no comprehensive discussion of the issues. In fact, many of the more serious misapplications of these tools are not in the mainstream professional literature but in the myriad of environmental impact statements, forest timber plans, community development analyses, and other applied impact studies. These studies often represent the attempts of regional planners, semiprofessional economists, or project promoters to apply tools and concepts learned or mislearned from professional economists.[1] This paper addresses five related methodological issues.

First, it usually is a methodological error to use project impact on value added as the measure of project regional benefits or costs. Changes in value added estimated with an I-O model consist of changes in income accruing to regional primary inputs, which are at least partly offset by the opportunity cost of diverting these resources from alternative employment elsewhere in the regional economy. What portion of regional income impact represents actual regional net benefit or net damage from the event?

Second, because all factor income is paid to people, who may or may not move in response to the event being studied, there is an ambiguity regarding what income and whose income should be counted when computing primary and secondary regional project benefits.

Third, as the level of economic activity changes in the affected industries of a region, they shift to different points on their average cost curves. How frequently do the affected industries exhibit economies or diseconomies of size sufficient to result in significant regional benefits or damages?

Fourth, because a regional I-O model traces each sector's purchases from other sectors of the regional economy, it captures only the portion of secondary impacts caused by backward linkages from the event being studied. Under what conditions are forward secondary linkages also important and how can they be estimated?

Fifth, I-O models are usually based on political boundaries such as counties or states, while the functional economic areas within which impacts occur often cross political boundaries. What are the implications of this divergence for correct estimation of regional project benefits?

Opportunity Cost of Factors Used

It takes production inputs to support the economic activity associated with a project or event, including any backward and forward linked secondary activity. These production inputs have an opportunity cost. Using the division that is both convenient and common in the literature, this section will address only the direct income impacts and those caused by backward linkages; a later section will address forward linkages.

Benefit cost analysis commonly assumes full employment of most primary factors of production, perfect resource mobility, and absence of scale economies (Howe and Easter, p. 26; Margolis). If these assumptions apply to all factors, then, even though the value added impact might be large, benefits would be zero because all factors employed with the project could have received essentially the same returns in alternative employment without the project. In other words, the income impact resulting from project-related activity is exactly offset by the opportunity cost of the resources used.[2]

Most applications of project analysis do make specific departures from these assumptions of full employment and complete mobility. Often one input, such as the water used by an irrigation project, is considered underutilized and immobile. Thus the opportunity cost of this resource is low. In this case, when the project's direct impacts on value added are translated into direct benefits by subtracting the opportunity cost of the inputs used, the direct net benefits consist of the residual increase in returns earned by the previously underutilized resource. Thus, the residual returns to water, after subtracting the cost of all other project inputs, is often taken as an

[1] Just and Hueth; Just, Hueth, and Schmitz; and Cooke have addressed the measurement of welfare change in a series of forward and backward linked industries impacted by some event. While their theoretical development contributes to understanding the issues presented in this paper, it is not clear that their approach is generally empirically implementable for cases such as those discussed in this paper, nor is it likely to soon replace the I-O-based approaches.

[2] While not the usual case, some projects do cause inputs to be used or combined in new ways. Such technological change can enhance the productivity of resources above their opportunity costs outside the project. However, productivity enhancement benefits should be attributed to a project for only the short run. In the long run, the normal course of technology adoption should establish the enhanced productivity levels as the new regional norm.

estimate of the direct benefits of a water project.[3]

The assumptions of full employment and complete mobility can often be applied plausibly to all inputs used in generating secondary project impacts. Thus, regardless of the size of the estimated change in value added from secondary impacts, it may be exactly offset by opportunity costs of the inputs used, leaving net secondary project benefits of zero. This posture is especially plausible from a national accounting perspective and is codified in the "Principles and Guidelines" for water resource projects (U.S. Water Resources Council), which directs that project secondary impacts must not be included in "National Economic Development" benefits.

Using the rule that net benefits equal impacts less opportunity costs, additional primary or secondary regional net project benefits may result if factor prices and factor opportunity costs diverge such that unemployed or underemployed resources persist in the region because of barriers to resource mobility. Little empirical work has addressed the level and nature of resource unemployment needed to justify including such benefits in regional project analysis. The few studies which have addressed the issue have relied more on assumption than on analysis of real data. The most prominent is the work by Haveman and Krutilla, who studied the labor and capital inputs required for water resource construction projects. They concluded that the national opportunity cost of resources used directly and indirectly by such projects ranged from 69% to 94% of market value, depending on the type and location of the project. This conclusion implies that between 6% and 31% of the income generated by these projects could be counted as net benefits.[4]

In his *ex post* study of the Colorado-Big Thompson water project, Howe (1987) assumed that 20% of capital earnings and 23% of wages and salaries represent net benefits. Hamilton and Gardner assumed that 10% to 20% of secondary value added by new irrigated agriculture in southern Idaho could be counted as net secondary benefits. In neither case were these assumptions based on empirical analysis.

Howe and Easter argue that if a region is highly dependent on a vulnerable industry and resources are immobile, then a much larger part of the value added resulting from a "rescue" of that industry can be counted as net benefit. However, Howe's "rescue" conditions will rarely, if ever, be met in practice. Even in Howe's negative impact scenario most of the released resources, except for some undepreciated immobile fixed assets, will eventually find other employment. The lifetime of most projects will be long enough to allow resources to move to their best use and to negate cyclical unemployment as an argument for secondary benefits. Even when short-run employment benefits exist, they can rarely be justified over the entire project life.

Most cases justify conclusions such as those reached in a chapter written by Hanke and Walker in the book by Haveman and Margolis: "Since there is no evidence that the conditions put forward by Margolis exist in the prosperous Mid-State area, secondary benefits have been eliminated from the analysis because they represent pecuniary transfers and not real effects" (Hanke and Walker, p. 343). Stabler, Van Kooten, and Meyer say: "Disregarding the possibility of declining long-run average cost curves in linked activities within the region, the general case for calculating secondary benefits on the basis of employable and immobile resources in Western North America is weak" (p. 20).

The burden of proof is on those who claim that a project uses labor or capital which would be unemployed without the project, therefore justifying the existence of secondary regional project net benefits, or the inclusion of additional value-added components in primary regional net benefits. Under most circumstances, the convergence between input prices and their opportunity costs restricts project direct regional net benefits to the residual returns to some particular underutilized target resource, such as the

[3] Large projects may result in some input and output price impacts; but Young and Haveman stress that these impacts should not be confused with benefits: "Pecuniary impacts (usually called 'secondary' or 'indirect' economic effects) are those reflected in changes in incomes or prices caused by shifts in supply or demand. Pecuniary externalities are likely to represent income distribution rather than allocative effects, and their inclusion would amount to double counting" (p. 190).

A related argument is that projects which produce consumer goods confer benefits of increased consumer surplus. Such benefits can occur in regional project analysis only if the additional production lowers local prices and a large portion of the product is consumed locally. Of course, the loss of producers surplus (value added from the depressed local prices can equal or exceed the consumer benefits which accrue to regional consumers. Such price change effects are difficult to address within the fixed price context of I-O modeling.

[4] In the context of benefit-cost accounting, project gross benefits are unaffected by whether some of the factors used were otherwise underemployed or unemployed. However, the difference between the factor prices and their opportunity cost is a "credit" offsetting some of the factor payments charged in the project cost account. Thus employment generation should not be counted a project benefit, but access to otherwise underutilized resources can reduce project cost, contributing to project net benefits.

water used by an irrigation project. Similarly, only a small portion (if any) of secondary income can be counted as secondary regional net benefits.

Treatment of Mobile Resources

Changes in direct and secondary regional economic activity of the kind discussed above usually result in some interregional movement of labor and capital. All factor income, whether earned by labor, capital or land, is paid to people. However, the people who receive that factor income do not always move in the same pattern as the labor and capital resources themselves. This results in a problem in deciding whose income counts when regional project benefits or costs are computed. This problem relates to the issue of accounting stance discussed in Stabler, Van Kooten, and Meyer.

The two polar possibilities are to count all or to count none of the income earned by immigrant resources. By definition regional income is the sum of the incomes of all residents of a region. Thus, the "all" posture would compare the sum of incomes accruing to everyone who would have lived in the region without the project and sum of incomes of everyone who will be living in the region with the project—with the difference proposed as an estimate of regional project benefits. While this approach occurs frequently in the project analysis literature, we question its validity.

The "none" alternative of not counting any of the income received by immigrants was advocated by Howe:

> The water manager . . . should act in the interests of the existing population of his area unless he receives policy direction from his constituency to the contrary. This point of view is the same as that taken by corporate financial managers in deciding the merits of new investments or stock issues, and is expressed in the question, 'Will the action dilute or enhance the equity of existing stockholders?' If this stockholder equity view were taken by city managements in general, continued urban growth might be seen in a different light. (page 12)

Similar positions were stated by Hamilton and Gardner:

> Insofar as regional project evaluation is concerned, it is the differences in value added generated by resources that would be in the region in the absence of the project which are relevant. It is debatable whether wages and salaries going to imported labor and returns to capital provided from outside the region (while a part of gross regional product), are valid regional benefits to those people who would have been residents of the region without the development. (page 8)

And, again, we see agreement in this statement by Keith and Glover:

> There is considerable controversy concerning the payments to imported labor as a regional benefit. If workers are transient, then long-term changes in payments to labor are not likely to result in large gains to the local economy. As long as it is a permanent change, imported labor represents an increase in resident population and household income. However, these benefits do not necessarily accrue to the population which was resident in the region prior to the project development, even though a substantial part of increasing service costs (such as schools, roads, etc.) and/or other costs (housing, food, etc.) may be borne by current residents. Thus there is a choice between estimating benefits to existing or to projected populations. If regional population growth is desirable, or is a direct goal of a project, then perhaps benefit estimates should include net income to permanent immigrants in the benefit calculations. However, any increasing costs of consumer goods or public services should be netted from the calculated benefits. It is highly doubtful that payments to imported capital will be paid to residents of the local community. In order to be as conservative as possible, to avoid counting benefits which may be fugitive (i.e., may not remain in the region), and to minimize the problems of calculating increases in, and distribution of, increasing social costs, *it is recommended that only benefits accruing to current residents of the region be calculated.* (page 22)

Consider an example. Assume that the impact of a new project causes someone from another community to take a new job in your community. Further, assume that the migrant's previous employment income was $30,000 per year and that person now earns $40,000 in the new job. Note that the aggregate accounting region consisting of both donor and recipient communities together has clearly experienced a $10,000 benefit; and $40,000 income increase in one community offset by a $30,000 opportunity cost in the other. However, from this aggregate accounting stance incorporating both the mover's origin and destination, no net resource migration has occurred.

The problem arises in measuring the benefit of this move to your community. Certainly the new individual's local spending for consumption or investment will stimulate local businesses, and some of this induced income may find its way to the residents of the community.

Other than this induced effect from respending, however, neither you nor other original members of your community benefit from the $40,000 income per se. Similarly, the remaining residents of the community that lost $30,000 employee may suffer some income loss because respending of this income has stopped, but they do not feel the loss of the $30,000 per se. It is the migrant alone who is the direct beneficiary of the $10,000 increase in factor payments.

Whose welfare should be included within the accounting stance used to determine the well-being of the region? To what extent does well-being of neighbors, especially new neighbors, enter into an individual's welfare function? For such questions economic theory can give little guidance. One plausible approach for a recipient community inclined to value growth is to count the $10,000 income net of opportunity cost (but not the entire $40,000 income of the migrant) as a net benefit. This is the benefit to the community residents from a happy new resident who has just experienced a $10,000 income increase. For the donor community, the emigrant may be out of sight and out of mind. Realistically, migrants are neither completely included in nor completely excluded from the community accounting perspective. The accounting stance advocated by Young and Howe, Hamilton and Gardner, and Keith and Glover would eliminate all direct benefits consisting of immigrant wages and count only benefits accruing to previous residents.

It is important to examine the assumptions implicit in this example. First, a $10,000 increment between donor and recipient regions could not coexist with full employment and perfect factor mobility. Second, if such a differential between the two regions did exist, it could only persist in the short run, supported by a labor immobility that the migrant has managed to overcome. In the longer run, either wages in the donor region will be bid up by continued out-migration, or wages in the recipient region will be depressed by continued immigration. Thus, the benefits to the recipient region attributable to migrant wage changes should be either nonexistent or short run.

What about the induced effects from the respending of the migrant's $40,000 income in the destination region? Clearly, as noted in the previous section, the multiplier effects will generate further secondary regional income. However, this increase in economic activity will draw resources away from alternative employment, so the opportunity costs of these resources must be deducted. Moreover, the induced effect will very likely be supported by the immigration of additional labor and capital, aggravating the problem of deciding whose income to count.

The situation is clearer for transient migrant labor. Income earned by labor that resides only temporarily in a region, while by definition a part of regional income, is certainly not valued very highly by other regional residents except as its respending induces activity elsewhere in the regional economy.

Similar problems are encountered with mobile capital. A new project will have both primary and secondary impacts on regional capital use and income. If internally owned capital is used, it has an opportunity cost equal to its value in its best alternative use. Inflows of monetary capital are not per se a regional benefit. It is the investment of this money in physical assets and the subsequent productive use of these assets that will generate regional incomes. However, capital attracted from outside the region, does not have zero cost, as implied in Howe (p. 79): "Insofar as these productive factors, including capital, are attracted from outside the project region, the loss of their outputs elsewhere will not be counted as costs in the project region's assessment of the project." Howe fails to note that importing this capital probably does not change its ownership. The price of importing capital to a region is the outflows of interest payments and profits sufficient to attract the capital, which is its exact monetary cost in the importing region and should approach its opportunity cost in the exporting region. Even for projects funded by government grant, this capital may have an opportunity cost in terms of other regional projects not funded (congressional logrolling also has its limits).

If a project attracts both capital and its owners as immigrants to the region, this clearly has a positive impact on regional income. The situation is similar to that for immigrant labor—one can question whether increases in profit and interest payment accruing to immigrant capitalists are per se a regional benefit. The existence of regional benefits depends on whether this new profit and interest income satisfy growth goals of the original community residents, and whether they can capture benefits from the economic activity induced by the local respending by the immigrant capitalists.

Another aspect of migrant resources is the impact that immigrant resources can have on local production processes. Immigration of labor or capital might enhance the productivity and re-

turns earned by local labor and capital. These are potentially important project benefits, which unfortunately are poorly modeled by fixed coefficient approaches such as I-O models. More research could productively be directed toward developing proper methods of incorporating these resource productivity benefits into project analysis.

Because much of the impact of projects is on income earned by immigrant labor and imported capital, this is one further reason the portion of estimated income impact, both primary and secondary, that can be considered a regional net benefit ranges from small to none.

Economies of Size

Reference was made above to changes in industry size as a justification for additional project benefits. In one sense, this is another way of viewing the underemployment/unemployment issues discussed above. Established firms in the region (the grocery store, the motel, the fertilizer dealer, the public school, and even the municipal government) may have adequate physical plant and labor to handle some increase in business. Similarly, on the downside, some decline in business may be accommodated without exit of labor or capital. Firms with considerable fixed labor or capital almost surely exhibit short-run size economies. On the other hand, if a firm's labor and capital can accommodate an expansion, then they must previously have been underemployed, or if the firm can tolerate a downturn without releasing labor or capital, that labor and capital must then become underemployed. In the long run, fixed assets must be replaced, and labor will move, ending this kind of short-run size economy benefits.

The issue goes beyond the fixed input/underemployment relationship. Long-run size economies may mean that a larger firm is better able to utilize labor or capital or has better market access than a small firm. Expansion of an industry may also result in agglomeration economies. Thus, an irrigation project might make possible the expansion of a livestock industry sufficient to give the meat-processing industry a cost advantage over competing regions. Regional growth may allow establishment of larger size, lower cost grocery stores, giving consumers the benefit of lower cost food.

On the other hand, any benefits flowing from industry size economies may be offset by other affected industries with either long- or short-run size diseconomies. Power generation in the Pacific Northwest experiences an increase in average cost as demand grows; present generation is based on cheap hydropower methods, while increases will have to come from expensive thermal sources. Expanding firms that need to add or replace fixed assets may operate only at costs above those of an established firm with depreciated fixed assets.

Because the I-O model is based on fixed coefficients, it is of little use for estimating size economy impacts. Attempts to estimate these impacts must be based on calculations external to the I-O model. Little empirical research has documented the role of economies of size in the affected industries as a determinant of the regional benefits or costs of resource development projects. Among the exceptions are work by Whittlesey et al., and Findeis and Whittlesey. They considered the incremental costs of providing energy supplies, incremental farm capital needs, and incremental social overhead costs associated with irrigation expansion.

Economies of size is a possible source for both primary and secondary project net benefits. However, because the fixed-coefficient I-O model is unable to incorporate size economies, it cannot be used to estimate these benefits. Further, the possible existence of size economies is not a valid justification for including I-O based estimates of secondary impacts as benefits. This is another area where research could be fruitful.

Forward Linkages

Forward linkage impacts occur if output from the directly affected sector serves as input to some other sector, thus changing the output level of that sector. For example, a new irrigation project may increase feed grain production, promoting an expansion in the regional livestock industry, which in turn could result in more meat processing in the region. As with backward linkages, some of the regional secondary income impacts produced by forward linkages may be valid components of regional secondary net benefits.

The I-O model, because it traces purchases of each sector from all others, is well suited for translating a primary impact on one sector into estimates of the secondary impacts on production and value added by the backward linked sectors of the regional economy. Backward linkages are sure to exist—production requires inputs, so changes in production will be felt by

sectors that supply those inputs. Forward linkage impacts are far less certain. If a region produces more feed grain, there is no assurance that regional livestock production will expand. If a region produces more logs, there is no assurance that they will be processed locally into dimension lumber, plywood, or houses.

Regional forward linkages exist only if the forward industries are otherwise constrained by input shortage and their expansion is a viable, profitable proposition. Often, the expansion potential of forward linked industries depends more on the regional and national market conditions for their outputs (meat, houses) than on the regional supply of raw inputs (feed grains, logs). If circumstances are unfavorable for the expansion of forward linked sectors, several possible scenarios exist. First, the raw product may simply be exported from the region. Second, especially for products that are hard to transport long distances, the increase in raw material production in the project area may cause regional declines in product prices, leading to offsetting production declines inside or outside the accounting region. Third, forward linked activity using inputs produced in the project area might increase, but an offsetting demise of such processing activities could occur elsewhere in or out of the region. For the first two scenarios, no regional forward linkage impact would occur. For the third, any regional impact occurs through transfer from another region.

The weakness of forward linkages is recognized by Hamilton and Gardner:

> Certainly some of the output of newly developed land will be fed to livestock, other crops from this land will be used as input to food processing plants, and these secondary activities will generate secondary value added. However, the demand for regional exports of processed food and livestock products is quite inelastic and driven largely by factors outside the region. We question the extent to which new irrigation actually increases the total amount of secondary food processing or livestock production in a region. Development may only mean that new farms rather than the farms present without development will supply a share of the inputs to these secondary activities. (page 8)

> Due to inelasticities of crop demand, the net effect of new irrigation on state crop acreage has historically been an increase in small grain and forage crop acreage with little increase in the acreage of higher valued crops. Essentially the acreage of high valued crops displaces existing acreage of these crops. (This treatment conforms to the federal Principles and Guidelines which mandate that returns to high valued specialty crops not be counted as part for the direct benefits of a water resource project.) (page 5)

This same weakness is recognized by Howe:

> There is no question that the availability of project agricultural outputs and the related demands for inputs led to the expansion of both forward (output processing) and backward (input supplying) linked activities in the project region. The sectors that are strongly forward linked to agriculture in the region are livestock and food processing. The markets for these final products are found almost completely outside the C-BT project region. It seems reasonable to argue that, had C-BT not existed, the additional supplies of these final products would have been produced elsewhere in the western United States. For this reason forward linkages can be ignored when computing net income changes from the national accounting stance, although not from the project region stance. (page 88)

If a project does cause secondary forward linkage impacts these will be in the form of output changes in other sectors and income earned by the production inputs used. The amount of this income impact that counts as regional benefit depends on the same opportunity cost considerations outlined for backward linkages. Labor and capital income impacts generated by forward linkages count as benefits only to the extent that the return in the new use exceeds its opportunity cost in its alternative use, and if some of these returns are captured by the permanent residents of the region. This will only be true if unemployment and immobility of labor and capital are substantial.

Young and Howe outline steps necessary to properly incorporate forward linkages into analysis of regional project benefits in instances when this is justified by market conditions and profitability of prospective industries. To estimate regional forward linkages if sector A increases output of raw material by Q_A, they note that one should:

> a. check the structure of local industries to see whether or not forward linkages appear likely;
> b. calculate the added processing output, Q_P, that is likely to follow from the availability of Q_A;
> c. insert Q_P in the input-output (inverse) model to determine what output changes will be required from all sectors other than that containing A;
> d. calculate the increased factor payments (i.e., to labor (households), rent, interest, profits) that the model predicts to follow from the increased output in all sectors other than A;
> e. estimate the opportunity costs of these newly employed factors to the state and subtract them from

> the increased payments calculated in (d) to get secondary net benefits. (page 69)

The issue is whether forward linkages exist, whether they fall within the accounting stance, and how they should be treated in empirical project analyses. We have outlined conceptual reasons that forward linkage benefits may be nonexistent or small. We conclude that the existence of forward linkage benefits must be justified empirically, case by case, using procedures like those outlined by Young and Howe.

Spatial Diffusion of Secondary Impacts

The above discussion has taken the project region as an internally undifferentiated partition of a uniform landscape. However, in the well-known sense of central place theory (Christaller, Losch), economic regions exist quite apart from the political regions superimposed on them, and these economic regions have a hierarchical internal and external trade structure. Regions used for input-output modeling are typically based on political units (states, counties, multistate or multicounty aggregates), easing data and model-building problems, and because the questions asked are usually framed in terms of political units. Both the trade patterns and the divergence between the boundaries of political and economic regions have consequences for regional project analysis.

Seninger noted that there may be clear policy and planning implications from an analysis of spatially diffused secondary impacts among a system of communities. Disaggregating impacts of a project to the community level may be helpful for understanding the nature of the impacts, planning how to deal with them, and deciding who should pay for them. By integrating central place and I-O theory, through an intercommunity I-O model (as in Robison and Miller), it is possible to trace the diffusion of secondary impacts through the central place hierarchy within a study region.

Ideally, I-O analysis should be used to model the economy of one or a hierarchical aggregation of functional economic areas (Richardson).[5] When an I-O model is shoehorned to fit the political units of data availability or to match the political boundaries of policy issues, the common nonsurvey techniques used to build these models can result in biased estimates of secondary project impacts (Robison and Miller). Economic impacts do not stop at political boundaries but usually spill across these boundaries into contiguous parts of a transcending economic region. The concept of interregional spillover is another way of looking at economic leakages from a region. Generally, small and less self-sufficient regions will have lower output and income multipliers because more spending leaks or spills into adjacent regions.

One can get a feeling for the spillover relationship from the output multipliers presented in table 1, which are based on the nested set of consistent I-O models from Hamilton and Jensen. As expected, Australia had the largest multiplier. The state of Queensland had a smaller multiplier because some secondary activity spills across its borders into other states. We can assume that each dollar of primary impact from some event in Queensland is associated with $0.71 of secondary impacts, the same ratio as for events elsewhere in Australia. However, Queensland captures only $0.55 of these secondary impacts while $0.16 of secondary impacts spill over to other states. The ratio of spillover secondary effects to those captured by the region is the spillover coefficient, 0.16/0.55 = 0.291 for Queensland. Moreton Region, containing Brisbane, the state capital, strongly dominates the economy of Queensland, allowing little of the secondary impacts from an event in that region to spill into other regions of the state. In contrast, an event in Toowoomba, a smaller town in Moreton Region, generates much more spillover secondary impacts than local secondary effects because it is so small and so strongly dominated by metropolitan Brisbane.

Interregional or multiregional I-O models (Miller and Blair) are appropriate analytic tools in cases where spillover effects likely are im-

Table 1. Australia Interregional Spillover Coefficients

Region	Average Output Multiplier	Spillover Coefficient to Next Higher-Order Region
Australia	1.71	
State of Queensland	1.55	0.291
Moreton Region	1.54	0.019
Toowoomba City	1.10	4.400

[5] In the 1970s, the U.S. Department of Commerce, Bureau of Economic Analysis (1975, 1982) relied on hierarchical trade and central place principles to map the economic boundaries of the United States. The BEA aimed at delineating a complete set of functional economic areas for the United States (see also Fox and Kumar). BEA Economic Areas generally have a "Standard Metropolitan Statistical Area" at the center, surrounded by a number of hinterland counties. While the BEA areas follow county boundaries, they often cross state boundaries to define a region comprising parts of two or more states.

portant. This framework explicitly models both the structure of each regional economy and the linkages between regions. In this way, the impact of an event in one region can be traced to all other regions. Such a multiregional model was constructed by Carter and Ireri as part of a study of the impact of California-Arizona water reallocation alternatives. Their results, shown in table 2, can be interpreted in terms of spillover coefficients. These results indicate that for each dollar of secondary impact generated in Arizona, an additional spillover of secondary impacts ranging from $0.058 to $0.822 will also occur in California.

The consequences of interregional spillovers can be important in regional project analysis. Miller examined the possibility that spillovers could be the basis of interregional feedback, where development in one region can spill over, stimulating development outside the accounting region, which in turn spills back to further stimulate economic activity in the first region. If such feedbacks are significant, an I-O model would underestimate the extent of project impacts.

The recent Pecos River case in the U.S. Supreme Court (482 U.S. 124, 1987) illustrates another kind of spillover relationship based on a resource allocation conflict between two adjacent political regions with an interlinked (nested) economic structure. In this case, if the accounting stance were based solely on the political boundaries, ignoring the hierarchical economic connections between the two areas, incorrect policy conclusions could easily result. The damages suffered by Texas for past underdeliveries of water by New Mexico under the Pecos River Interstate Compact include direct and secondary income losses net of the opportunity cost of the resources used. However, New Mexico would have had to reduce its irrigated acreage by at least 20 acres for each additional acre that could be irrigated in Texas. The 20 to 1 ratio is a consequence of the lags in the groundwater hydrology of the region, the evaporation losses, and the salinity buildup of Pecos River water delivered to Texas. The economies of the affected part of New Mexico are closely tied through strong forward and backward linkages to the adjacent parts of Texas. The question is: What would have been the net benefits to Texas if it had received the water and the direct and secondary impacts which that implies, but at the cost of losing spillover benefits because of the associated reduction in New Mexico irrigated acreage?

Table 2. Secondary Impact Spillover Coefficients from Arizona into California

Sector	Coefficient
Meat animals & products	0.058
Poultry & eggs	0.822
Farm dairy products	0.122
Food & feed grains	0.247
Cotton	0.102
Vegetables	0.197
Fruit & nuts not citrus	0.197
Citrus	0.145
Forage	0.199
Miscellaneous agriculture	0.102
Grain mill products	0.201
Meat, poultry process	0.124
Dairy products	0.064
Can, preserve, freeze	0.813
Misc. agr. processing	0.301
Chemicals & fertilizer	0.309
Petroleum	0.152
Fab metal & machinery	0.335
Aircraft	0.181
Primary metals	0.134
Other manufacturing	0.144
Mining	0.079
Utilities	0.062
Selected services	0.115
Trade & transport	0.058
Other services	0.115

It is interesting to note that the two New Mexico counties which would have lost irrigated acreage under compact compliance are designated by BEA as part of the El Paso, Texas, functional economic area. The Texas-New Mexico border runs neatly between these New Mexico counties and the El Paso, Texas, SMSA that is the principal central place in this functional economic area. Because of the obviously close economic ties between these portions of New Mexico and Texas, actions taken in New Mexico should have large spillover effects in Texas. In this case, there is a real possibility that the spillover benefits accruing to Texas from using the water in New Mexico would exceed the direct and secondary damages of not having the water to use in Texas, leaving Texas better off because it did not get the water. However, if analysis was based on separate I-O models of the affected New Mexico and Texas areas, ignoring the economic linkages between the two, these potentially important spillover effects would remain hidden.

Note the internal consistency; if factor opportunity cost were 100% of factor market cost, then there were no secondary benefits to New Mexico from using the water and no spillover benefits to Texas; however, if factor unemployment or immobility is invoked to justify sec-

ondary benefits, then spillovers are also a possibility.

The divergence between the political regions often used for regional modeling and the functional economic areas in which economic activity actually takes place sometimes causes analysts to incorrectly specify their accounting stance, resulting in biased estimates of project impacts and project benefits and missing important benefit spillovers between accounting regions.

Conclusions

This paper has addressed five issues that are encountered when estimating secondary benefits in regional project analysis: (*a*) the proper correction for the opportunity cost of factors used, (*b*) how to treat mobile factors, (*c*) the effect of economies of size, (*d*) the role of forward linkages, and (*e*) the role of the spatial structure of economic regions. The first four issues serve as reasons only a small part, if any, of regional impacts can be treated as regional net benefits or costs. The fifth is a reason that, when secondary benefits or damages do exist, their correct estimation can depend on recognition of the spatial structure of the affected areas. All five serve as cautions to the project analysis practitioner and as challenges for future conceptual and empirical research.

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